DEVICE FOR THE PURIFICATION OF MACHINING LIQUIDS FOR ELECTROEROSION MACHINES

The present invention relates to a device for the purification of machining liquids for electroerosion machines provided with an electrode adapted to machine a piece, the machining liquid being constituted by a dielectric liquid containing at least first particles of an additive adapted to facilitate electroerosion and second particles of contamination from the electrode and/or the piece and having a higher density than the first particles.

It has been demonstrated that, during machining with an electroerosion machine, the use of an additive in the form of a powder having particles of the order of several microns, greatly improves the machining performance, see for example Swiss patent 670,785.

During machining by electroerosion with powder and particles as additives, the principal element not solved is the filtration and purification of the used and contaminated machining liquid.

There are encountered in this latter, particles of the additive, particles in the form of metallic spherules of the material of the piece and of the electrode, as well as particles of colloidal carbon in the form of submicron size in the case of carbonated dielectric liquids.

An ideal filtration should retain only the dielectric liquid and the particles of additive. Conventional filtrations however do not permit obtaining the desired filtration, because a coarse filtration (> 20 µm) lets pass many fine metallic spherules. On the contrary, a fine filtration eliminates, in addition to the metallic spherules, the additive powders. A magnetic separation works only for magnetic metallic spherules, but not for all the other spherules.

The present invention has for its object to overcome these drawbacks and to provide a purification device permitting obtaining a high degree of purification and this with means that are simple to use and at a moderate cost. The invention is characterized to this end by the fact that the device comprises at least one ultrasonic decantation device comprising a first decantation receptacle for the machining liquid in which is disposed a first ultrasonic emission member connected to a first ultrasonic generator whose power can be adjusted such that the second particles decant whilst the first particles remain in suspension in the dielectric liquid.

These characteristics permit obtaining a good purification of machining liquids and a device of moderate cost which is simple to use and rapid and reliable in operation.

The device moreover can comprise preferably means for supplying contaminated machining liquid to the first decantation receptacle and at least one opening provided in this latter for the discharge of purified machining liquid containing the first particles.

According to a preferred embodiment, the device comprises supplemental means to separate third contamination particles constituted by colloidal carbon from the decomposition of the machining liquid, these supplemental means comprising a second ultrasonic decantation device with a second decantation receptacle in which is disposed a second ultrasonic emission member connected to a second ultrasonic generator, the power of this latter being adjusted such that the first particles decant, whilst the third particles remain in suspension in the machining liquid, this second decantation receptacle comprising an inlet connected to said opening.

This embodiment is particularly well adapted for the processing of carbonated dielectric machining liquids, such as oil, which permit purifying to a high degree of purity.

Preferably, the supplemental means comprise a mixing receptacle having mixing members, filtration elements for the machining liquid obtained by decantation at the outlet of the second decantation receptacle and arranged to retain by filtration the third particles, a filtered dielectric liquid

supply conduit from the filtration elements to said mixing receptacle, and extraction and transport means arranged to transport the first decanted particles from the second decantation receptacle to the mixing receptacle.

By these characteristics, the carbonated dielectric liquids can be purified effectively and reconstitution of the complete machining liquid can be carried out in a reliable and inexpensive manner.

Other advantages will become apparent from the characteristics set forth in the dependent claims and from the description given hereafter of the invention, in greater detail, with the help of the drawings which show schematically and by way of example two embodiments.

Figures 1 and 2 are schematic views of a first and second embodiment.

With reference to Figure 1, electroerosion machine 10 is provided with a first embodiment of the decantation device 11.

This electroerosion machine comprises a working receptacle 12 in which is contained a machining liquid 14 and a piece 15 to be machined mounted on a work table 16. The electroerosion machine moreover has an electrode 17 serving as a machining tool, mounted on a spindle 18.

The machining liquid 14 is circulated and temperature controlled in the working receptacle 12 thanks to a mixing installation 20 comprising a pumping circuit 21 with a suction pump 22 and a heat exchanger 23 connected to a cooling water circuit.

The machining liquid 14 is constituted by a dielectric liquid in which are suspended first particles of an additive adapted to facilitate electroerosion and second particles of contamination from the electrode and/or the piece 15 to be machined. The first particles could for example be graphite particles of a density of 2 to 2.2 g/cm^3 and a granulometry between 1 and 100 µm, preferably between 1 and 10 µm. The second particles are generally present in the form of metallic spherules torn off and ejected from the piece to be machined and from the electrode during erosive discharges. Their density, greater than that of the first particles, is comprised between 4 and 20 g/cm^3.

The granulometry of these spherules is generally comprised between 1 and 40 µm.

When the dielectric liquid is of a carbonated nature, the machining liquid can moreover comprise third particles in the form of particles of colloidal carbon caused by the decomposition of the dielectric liquid under the influence of the erosive discharges, which have the tendency

to flocculate in submicron particles. The density of these third particles is less than 2 g/cm^3 and their diameter is generally less than 0.5 µm. Of course these third particles do not exist in the case of water as the dielectric liquid.

The first embodiment of the decantation device 11 has a decantation receptacle 30 for the machining liquid in which is disposed an ultrasonic emission member 30 in the form of a sonotrode. This latter is connected by a connection 32 to an ultrasonic generator 33 of a frequency of 40 kHz and whose power can be adjusted, for example from 10 to 200 watts. A conduit 34 provided with a suction pump 35 serves as supply means for the contaminated machining liquid into the decantation receptacle 30. At least one opening 36 connected to an outlet conduit 37 permits returning the machining liquid purified from the second contamination particles, to the electroerosion machine, either into an attached reservoir, or directly into the working receptacle.

Ultrasound is a very effective way to place in suspension particles of the size of the first particles of the additive powders. The ultrasonic energy for suspending the particles must be higher the greater is the density of the particles and the greater is their size. It is to be noted that below a critical size, the density has less importance than the size for suspending by diffusion. Decantation is

moreover slowed when the viscosity of the machining liquid increases. It is thus possible to provide a selective decantation device operated by moderate ultrasonic energy. The power of the ultrasonic generator 30 is adjusted for each density and viscosity of the machining liquid and each density and size of the particles to be separated. The optimum adjustment permits decantation and accumulation on the bottom of the decantation receptacle, of the second contamination particles 38, namely the metallic spherules, whilst keeping in suspension the first particles 39 that are lighter, of the additive, such as graphite.

The power of this generator 33 is thus generally adjusted between 10 and 150 watts, preferably between 4 and 100 watts.

Such a decantation device suffices for the case of water as the dielectric liquid, it can also be used in this form if it is acceptable to let the first particles subsist with the third particles of carbon from the decomposition of a carbonated dielectric liquid, such as oil.

The separation and elimination of the third particles requires a more complete purification device, of which one embodiment is described with reference to Figure 2.

This second embodiment comprises a first decantation device 11 identical or similar to that described with

reference to Figure 1. It is moreover provided with supplemental means 40 adapted to separate the third contamination particles 41 of the machining liquid from which has already been decanted the second particles 38. These supplemental means comprise a second decantation device 45, filtration elements 46 and a mixing receptable 47.

The second decantation device 45 comprises for this purpose a second decantation receptacle 50 in which is disposed a second ultrasonic emitting member 51, in the form of a second sonotrode connected by a connection 52 to a second ultrasonic generator 53.

The outlet conduit 37 of the first decantation device 11 serves as a supply conduit for the machining liquid containing the first and third particles.

The second ultrasonic generator 53 has a frequency of 40 kHz and its power can be adjusted for example between 1 and 30 watts, preferably between 5 and 20 watts. Its power is thus adjusted to be lower than that of the first generator 33. It is adjusted to maintain in suspension the third particles 41, whilst the first particles decant and accumulate on a conveyor belt 55 serving as an extraction and transport means to bring these first particles 39 above the mixing receptacle 47, where they are discharged.

An outlet conduit 56 provided with a pump 57 supplies machining liquid with third particles 41 to the filtration elements 46. These latter are arranged to retain all the third particles 41 and comprise to this effect at least one fine filter, for example a paper cartridge filter. The dielectric liquid 58 thus purified is conveyed by a conduit 59 into the mixing receptacle 47, where it is mixed with the first particles by mixing members 60, such as paddles or air circulation, etc. The purified and thus constituted machining liquid is then returned by a pipe 61 and a pump 62 to the electroerosion machine.

These purification devices are particularly important for rough machining and for semi-finishing and permit eliminating the largest metallic particles which would otherwise be very troublesome during subsequent finish machining.

Of course, the embodiments described above are in no way limiting and can be the subject of any modification desirable within the scope defined by claim 1. In particular, other devices could be added, such as washing or any other treatment of the first additive particles leaving the second decantation receptacle 50, a measured supplier for the first particles permitting obtaining an exact concentration of the first particles in the machining liquid contained in the mixer 47, an extraction device, for example a conveyor, for the second

metallic particles of contamination into the first decantation receptacle 30. All of the purification device could be integrated into the electroerosion machine or constitute a unit separate from this latter.